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ABSTRACT

This publication discusses the use of risk strategy for the organization and management of health care services for mothers and children. Individuals and groups with an increased expectation of complications or disease are defined as being "at risk" and the aim of the health services should be to identify them as early as possible and to intervene in order to reduce the risk. Specific components of this approach are described in some detail. These include (1) identification of characteristics of women and children associated with increased risk of undesirable outcomes, (2) development of methods for detecting at-risk individuals in local conditions, (3) training of health care personnel in these methods, and (4) provision of methods to prevent or ameliorate undesired outcomes. An example is given of a decision pathway--a possible approach to the selection of intervention strategies based on defined outcomes, risk factors, resources, constraints and manpower availability. Also included are a list of the basic components of a health information system and a brief discussion of the field testing of local risk strategies. Appendices give further examples of risk factors, scoring systems for assessing risk, and intervention strategies; notes on resource allocation and evaluation methods; and examples of ways to expand general program objectives.
(Author/JMB)

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RISK APPROACH FOR MATERNAL AND CHILD HEALTH CARE

PS 010033

WORLD HEALTH ORGANIZATION
GENEVA, 1978

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RISK APPROACH FOR MATERNAL AND CHILD HEALTH CARE

A managerial strategy to improve the coverage and quality of maternal and child health/family planning services based on the measurement of individual and community risk

PS010033

WORLD HEALTH ORGANIZATION
GENEVA
1978

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PREFACE

Recent years have witnessed a growing consciousness on the part of all who are concerned with health development that the need is urgent to improve the quality and the extent of the delivery of health care, particularly for underserved and underprivileged populations. There has been a constant endeavour to develop new methods and approaches that will better meet the great challenge of health care.

The development of the "Risk Approach" for improved maternal and child health care by a WHO Task Force, expounded in this book, is the reflection and result of this constant search for promising approaches.

The risk approach can be considered as a managerial tool for the flexible and rational distribution of existing resources, based on measurements of individual and community risks, and for developing local strategies and determining the appropriate content of maternal and child health and family planning care. Inherent in this approach is maximum utilization of all resources, including some human resources that are not conventionally involved in such care - traditional birth attendants, teachers, women's groups, and agricultural workers, for example. It also allows for and promotes self-reliance for health care in the community and the family, particularly by the mother for the dependent young child. Although the approach has important potential for improved coverage and quality of care in developing countries, it is also useful for developed areas.

The concept and methodology of the risk approach, as outlined in the following pages, are most suited to the needs of maternal and child health care and family planning, particularly as part of primary health care, since this type of care requires continuity of inputs and supervision. It may, none the less, have wider implications for the health system as a whole. Obviously, the effectiveness and efficiency of this approach have to be further tested in field conditions, and, like any other new concept, the approach is bound to be enriched, refined, modified and improved as a result of its practical application.

It is hoped that this publication will be of interest and help to development planners, to national health planning and programming bodies, and to managers, teachers, and workers of maternal and child health and family planning care. It is presented as part of WHO's efforts to promote rational planning and implementation of services that will respond to the needs and aspirations of populations, have a definite impact on health problems, and help towards the objective of health for all by the year 2000.

SUMMARY

In spite of the considerable efforts that have gone into the creation and improvement of health services, there are many areas of the world where access to medical care is very limited for most of the population. Paradoxically, at the same time, high quality health services may be available to small sections of the population, universal coverage being limited by lack of money and of trained manpower. There is thus a need to seek ways of making the optimal use of existing resources for the benefit of the majority, particularly through the use of the primary health care approach.

1. Risk strategy is one managerial tool for the organization of health services - in particular for mothers and children. Its aim is to give special attention to those in greatest need within a framework of improved health care for all. Individuals and groups with an increased expectation of complications or disease are defined as being "at risk" and the aim of the health services should be to identify them as early as possible and to intervene in order to reduce the risk.

2. Health service organization based on this approach will require the identification of those characteristics of women and children (risk factors) that are associated with increased risk of undesirable outcomes, the development of methods for detecting them in local conditions, the training of health care personnel in these methods, and the provision of methods to prevent or ameliorate undesired outcomes.

3. Risk factors may be defined as the characteristics or circumstances of a person or group that are associated with an increased risk of having, developing, or being especially adversely affected by a morbid process.

First pregnancy, high parity, too frequent pregnancies, pregnancy at the extremes of reproductive age, previous child loss, and malnutrition are examples of universal risk factors, which increase the chances of a poor outcome of pregnancy. For the infant, large families, crowding, illiteracy, and poor sanitation are well known examples of risk factors, e.g. for gastroenteritis as for a number of other diseases. Certain risk factors are specific for particular outcomes, but more often one risk factor - grand multiparity, for example - increases the frequency of various undesirable outcomes.

In some situations, culture and customs may act as risk factors by limiting the education or status of women, by prescribing or withholding certain foods during pregnancy, or by perpetuating unhygienic practices. In others, the climate, the non-availability of certain foods, or poor environmental sanitation increase the risks for both mothers and children.

4. Detection of risk factors requires a knowledge of the characteristics associated with poor outcomes and the ability to recognize and measure them. Some factors are easily detected even by the untrained health worker, e.g., age, parity, maternal height, and previous fetal or child loss. At this level, clear instructions must be given as to the action to be taken in each case.

With increased training, the proportion of detectable factors increases, leading to improved precision in predicting outcomes. Measurement of blood pressure, detection of twin pregnancy, and estimation of haemoglobin level are examples of methods of detecting further risk factors during pregnancy that require additional resources, and the list could be extended very considerably, given the facilities of a university hospital. For the infant, the measurement of birth-weight, monitoring of growth, and knowledge of feeding practices all give desirable bits of information that permit the detection of risk factors and facilitate early intervention.

5. Detection of individuals at risk will require contact, however superficial, with every woman and child in the community and, in turn, will lead to a reconsideration and reallocation of resources with better coverage. The need to observe, to measure, and to decide on action will increase the awareness, involvement, and efficiency of the health worker at every level.

For management of the health services, therefore, risk strategy offers a rational approach to allocation of resources, wider coverage, and a system of monitoring to provide health information and continuous evaluation.

6. Development of intervention strategies. The principles of health care delivery may be universal but the strategy needs to be developed by each country to meet its own needs and within its own constraints. It might frequently be necessary to develop different strategies for different areas within the same country.

There is thus a need for appraisal of the health problems of women and children in each locality, taking into consideration individual characteristics as well as the effects of the physicochemical, biological, and social environments. The needed intervention may well involve not only treatment of the individual to reduce risk but also community advice on family spacing, health education to change feeding patterns, and development programmes to improve food production and environmental sanitation.

Decisions must be taken, based on local patterns of epidemiology and availability of resources, as to the action to be taken at each level and the tasks of each member of the health team, including policies for referral. These, in turn, have clear implications for training and supervision and for the organization of the health services generally.

7. A health information system is an essential part of the strategy, providing, at levels consistent with local resources, information on the population at risk, the services provided and their utilization and the results achieved. This knowledge can then be used to extend coverage, to change practices, to reallocate resources, and to monitor the consequences of such improvements.

8. Trying the method in different countries. As a first step in the implementation of this strategy it is necessary to undertake limited field trials. The objectives of these trials are to elaborate guidelines for the development of local strategies for mother and child care and family planning, under field conditions, to test their validity in terms of detection of cases and modification of outcome, and to measure the implications of this approach for resource allocation and manpower development.

9. To sum up, the risk strategy, while nominally directed to those mothers and children at special risk for disease and death, should have far-reaching effects on the whole organization of maternal and child health/family planning (MCH/FP) services and lead to improvements in both the coverage and quality of health care, at all levels, particularly at primary health care level.

1. INTRODUCTION

1.1 Risk strategy and "standards" of care

In every community, mothers and children are among those groups that are vulnerable to disease, disability, and death. Their vulnerability is a result of the possession of the special characteristics of pregnancy or young age, related to biological processes of reproduction, growth, and development.

Within these groups, certain individuals are at special risk of disease or complications because of factors in their biological make-up, their environment, or both. Such factors, called risk factors, exert their effects both singly and in combination, the relative importance of each varying with the individual and the socio-ecological conditions.

Equitable provision of health care requires special attention to vulnerable groups and, within them, to those at risk. Such attention should also facilitate the most efficient use of scarce resources for prevention, care, and cure. Risk strategy, therefore, is a managerial tool for the organization of health care. Its purpose is to provide better services for all, but with special attention to those who need them most.

Much effort by governments and international agencies has gone into the development of health services, particularly in developing countries. Despite considerable progress, there remain many areas of the world where access to such services is limited to less than a quarter of the population. The tendency to copy health services of richer countries has usually resulted in the creation of "islands of excellence" which offer standards of health care delivery, designed for quite different situations, to a minority of the population.

There is thus a need for a more realistic approach to the health problems of developing, and, in many cases, developed areas - one that will make the best use of existing resources for the benefit of the majority. While the technology of health care delivery may be universal, each country needs to develop the strategy to meet its own needs.

In developing local strategies for the delivery of family health care with optimal coverage, efficiency, and efficacy, the concept of risk groups and individuals is a promising basis for a useful managerial approach. Its purpose is to:

(1) identify the real health needs of the population, define the roles and functions of the different categories of health personnel, and develop suitable training programmes;

(2) obtain a better diagnosis and measurement of human reproductive casualties in communities where health information is deficient and provide a mechanism for surveillance of the population "at risk" that will facilitate the development of realistic standards of care;

(3) make predictions regarding the level of care required by different individuals or segments of a community, according to the probabilities of their becoming sick, during the processes of reproduction, growth, and development;

(4) provide anticipatory care to individuals and groups with characteristics indicative of a special risk to their health, welfare, or life;

(5) improve knowledge and develop criteria for the allocation of health resources in order to contribute to the rational planning, organization, administration, and evaluation of health services.

A WHO Task Force[1] on "Risk Approach" for improved maternal and child health and family planning developed the concept of the use of the risk approach in MCH/FP care. The aspects covered included risk, outcome and measurement, managerial implications of the risk approach, development of local strategies, decision processes in selecting intervention measures, health information, and implementation and evaluation of the risk approach.

[1] Members of the task force are listed in Appendix 4.

2. RISK, OUTCOME, AND MEASUREMENT

2.1 Concepts and definitions

A dictionary definition of the word "risk" is "hazard, danger, exposure to mischance or peril". It implies that the probability of adverse consequences is increased by the presence of some characteristic or factor.

For use in the present context, the following modification of the definition proposed by a WHO symposium on the identification of high risk persons and population groups [1] was adopted:

A risk factor is any ascertainable characteristic or circumstance of a person or group of persons that is known to be associated with an abnormal risk of having, developing, or being especially adversely affected by a morbid process.

Several studies have shown that first pregnancy, high parity, pregnancy at early or late reproductive age, previous child loss, and malnutrition are universal risk factors, possession of which increases the chance of a poor outcome of pregnancy. Combinations of these, and other, risk factors in the same individuals further raise the chance of a poor outcome. Moreover, the interaction of biological risk factors with others derived from the social and environmental setting will also have an effect. For example, multiparity in young mothers living in poverty usually results in high perinatal mortality.

Risk factors are, in fact, characteristics that have a significant association with a defined end-point. It is important to specify the end-point or outcome for which each risk factor or group of factors is sought. The characteristics of mothers whose infants have an increased chance of dying from hypoxia during delivery, for instance, may be quite different from those of mothers whose infants die more usually from gastroenteritis.

Thus, risk factors may be specific for a particular outcome, such as previous artificial abortion leading to cervical incompetence. More frequently, one risk factor increases the frequency of occurrence of a number of end-points. An example is grand multiparity with its increased risk of several complications of pregnancy and delivery, such as transverse lie, antepartum haemorrhage, and premature and precipitate birth.

2.1.1 Relationships between risk factors and defined outcomes

These are of three kinds:

(1) Causative, triggering off pathological processes. Examples include maternal malnutrition and low birth-weight, placenta previa and fetal death from anoxia, or first trimester rubella and congenital malformations.

(2) Contributory, such as chronic malaria leading to pregnancy anaemia and its complications, and grand multiparity facilitating transverse lie and prolapse of the cord. In this group, there is usually a clear connexion between the risk factor and the outcome although the factor is not the immediate cause.

(3) Predictive, or associative in the statistical sense. In this group, the characteristics that make up the risk factor are themselves associated with underlying causes, unidentified or ill-understood. A woman with previous fetal or child loss is at greater risk of losing her next infant. The toddler whose mother works outside the

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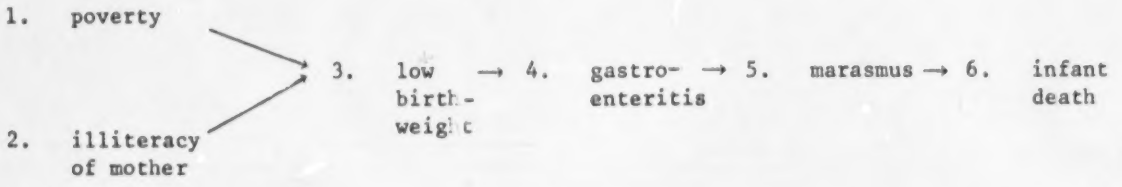
[1] WHO Regional Office for Europe. Symposium on the identification of high risk persons and population groups, Windsor 1972. Copenhagen, 1973 (EURO 4911).

home is more likely to be involved in an accident. A common example is the association between poverty and infant gastroenteritis where the complex of poverty may include large families, crowding and poor nutrition, with infection of the infant and neglect of early diarrhoea for a variety of reasons, economical, social, and cultural. Even without elucidating the pathways of causation, it is clear that poverty of the family is a risk factor for gastroenteritis of the infant. One chain of relationships could be drawn as follows:



Each of the six indicators may be regarded both as a risk factor and as an unfavourable outcome.

2.1.2 Individuals and groups

The observation that residents of certain areas at certain seasons are more exposed to "fevers" dates back to Hippocrates. Ramazzini documented the increased risk of disease in defined occupational groups at the end of the 17th century, while nearly 140 years ago William Farr demonstrated increased mortality among residents of large English cities with the greatest danger to those living in certain boroughs of London. Today, migrants living in the shanty fringes of many cities are at a greater risk of tuberculosis and sexually transmitted diseases, while every country has its "black spot" areas with high infant mortality and morbidity. Type of employment or place of residence can thus be associated with added risk of death or disease for groups of individuals, whatever their individual susceptibilities.

The possibility of identifying risk groups by group characteristics, without the necessity for a priori personal contact, may be used in evolving an intervention strategy and is referred to below.

2.1.3 Extent of risk

The point has been made that risk factors are characteristics of the person or environment having a statistical association with the defined outcome. Except for rare, dominant, inherited disease, this association is far from a 1:1 relationship. For example, smoking during pregnancy carries a risk of increasing the perinatal mortality, according to one study, from 20 to 30 per 1000. However, over 90% of pregnant smokers have healthy surviving babies, albeit of lower average birth-weight.

Thus the importance of the risk factor depends on the degree of association (the "weight") with the outcome, as well as the frequency of the outcome in the community. If a certain risk factor were to carry a high probability of, say, fetal death, but this risk factor were uncommon in the community, the impact on total fetal mortality would be small (Section 2.3).

2.2 Identification of those at risk

Identification of risk factors began with the observation of the association of certain characteristics with an undesired result. Early attempts to use this information were simple and ad hoc, designed to alert the physician, while families were usually thought of as falling into one of two groups under each "risk" heading. Thus, in the early work of Baird in Aberdeen, mothers were either poor (with increased risk of a bad pregnancy outcome) or not, tall (good) or short (bad), having their first child under 18 (bad) or between 18 and 26 (good), well or malnourished, and so on. Biochemical and blood pressure variables were handled in much the same way and the resulting strategies were surprisingly effective, in spite of the fact that only the most

limited interactions were considered. Physicians were alerted to the need for special care by the risk indicators.

In much the same way, broad risk groups were defined for childhood accidents.[1] In England, the child aged two to five years who is at high risk from motor vehicle accidents is most likely to come from a family in which there have been other accidents, in which there is a mother preoccupied with other, younger siblings or with illness, who is herself a poor risk, where there is no garden, yard, or playground, and so on. The risk groups could thus be defined, although the knowledge had little impact on strategies for prevention for a long time.

As already noted, certain characteristics of the mother have been repeatedly shown to be associated with poor outcomes of pregnancy such as perinatal mortality. These characteristics include older age, high parity, maternal disease, and poor obstetric history, among many others; these factors for perinatal mortality have been dealt with in detail by a WHO Expert Committee.[2]

It is probable that several risk factors which have so far been identified in only a few countries are of universal importance. However, the findings on which present knowledge is based cannot be extrapolated to all situations in all countries without further information (see Section 2.4). There is no substitute for epidemiological studies, including reproductive patterns, of the population under consideration.

The main concern of the task force was the development of an approach to decision-making in resource allocation on the basis of the risk principle. While it is logical and just to direct limited resources to those who need them, the problem is to identify those who are at risk. The application of the principle can be at levels that vary according to the individual or the group. The decisions how, when, and where to intervene will depend on the importance of the factors in the special circumstances, the chains of causation, and the resources available for intervention (see Section 2.4). It takes more effort to identify high-risk individuals, rather than groups, as this requires contact with each member of the pregnant or infant population.

An approach has, therefore, been made to the identification of groups at risk. Some of the groups at risk of, for instance, high perinatal mortality are characterized by poor housing, overcrowding, and residence in certain neighbourhoods. Especially in urban and peri-urban situations, information on overcrowding, housing, water supply, and environmental hygiene, for instance, may be available for geographical areas and this can be used as an indirect means of identifying populations. In one city, families that had had infants who died of gastroenteritis were found to differ from other families by neighbourhood of residence, parental education, and occupation. They did not differ from other families in their use of antenatal care or in place of delivery and type of birth attendant. A comparison of housing showed water and toilet facilities to be distinguishing factors. In this example, the conclusions were that improvements in hygiene and the social environment would have greater impact on the outcome (death from infantile gastroenteritis) than the provision of additional health care facilities.

In another urban situation there was an inverse correlation between the municipal tax level, which indicated the socioeconomic level of the neighbourhood, and the number of hospitalized infants with gastroenteritis. Other studies have demonstrated increased risks for a number of outcomes in families of slum dwellers, migrant workers, and unmarried mothers, to name but a few groups.

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[1] Backett, E.M. Domestic accidents. Br.med.J., 1: 409 (1959).

[2] WHO Technical Report Series No 457, 1970. The prevention of perinatal mortality and morbidity. Report of a WHO Expert Committee.

2.3 Measurement of risk

The process of measuring risk factors and the development of scores for practical use can be described in the following sequential stages.

2.3.1 Defining outcome and its frequency

Events that are uniformly fatal but excessively rare, although of great importance to the affected individual and the family, may require more resources than are available for early detection and prevention. This is true even in rich societies, as, for example, in the case of amniocentesis for the detection of genetic defects. Some conditions will thus have a low priority in intervention strategies. Similarly, others which, though uncommon, involve survival with the need for continuous care, e.g., spina bifida with meningomyelocele, will have a different priority, depending on social pressures and available resources. Again, a common minor disability might be of greater priority for prevention than a more severe disability that is rare.

It is thus essential to define those outcomes - death, disability, or modification of the quality of life - requiring intervention, to measure their frequency, and to rank them in some way, depending on their importance to society and the possibilities of prevention and treatment. Perception of "importance" will, naturally, vary from culture to culture.

Where vital statistics are adequate, there will be information as to the frequency of live- and stillbirths and on neonatal and infant mortality. In some areas, there may have been surveys of maternal morbidity and childhood handicaps. At the opposite extreme, where no data are available, it is often possible to obtain a consensus, based on discussions with local leaders and health workers, as to the frequency of occurrence of a defined event. By asking about a number of events, it may be possible to rank them, e.g., event A as more common than B but more rarely seen than C (Section 4.3). At the same time a score can be given to the seriousness of an event as seen through local eyes and this may give some guidance as to priorities for intervention (Sections 2.3.4 and 4.1). This process will permit decisions on intermediate strategies and training programmes (see Section 4), pending the results of an epidemiological survey to obtain more precise information.

2.3.2 Detection of risk factors

The next step in strategy design will be measurement of those characteristics of mothers, children, and the environment that are associated with defined events or outcomes. It is probable that as many as 80-90% of the risk factors that have been identified to date, mainly in developed countries, are of biological significance and thus probably of universal application.

For perinatal mortality and morbidity, for instance, they will include age, parity, maternal habits, infections, toxaemia and bleeding during pregnancy, availability and type of antenatal care, obstetric performance and standards of obstetric intervention, and facilities for resuscitation and later care of the newborn. Reference has been made above to the association of poverty, low level of parental education, and disease - for instance, gastroenteritis in infancy.

To sum up, risk factors are defined as those characteristics that are more frequent in persons or groups in which the specific outcome is common than in others - how much more frequent they are will need to be decided by epidemiological studies. The threshold of frequency or the level of association that transforms a characteristic into a risk factor has now to be discussed.

2.3.3 Weight of the factors contributing to risk

The point has been made that only a small proportion of infants born to women who smoke during pregnancy die in the perinatal period. But smoking during pregnancy does

raise the perinatal death rate considerably and therefore must be considered as a risk factor for that outcome. By convention, defined characteristics are accepted as risk factors if the undesirable outcome associated with them is significantly more frequent in persons with those characteristics than in those without them. Table 1 lists examples of risk factors that have been demonstrated in a number of studies to be of importance for maternal and perinatal mortality and morbidity.

One method of measuring the weight of the risk factor is to compute the incidence, or mortality, rates for the general population and compare these with the same rates for those possessing the factor. Thus, in the British Perinatal Mortality Survey,[1] the perinatal mortality rate for infants born to women of parities 5 to 8 was 1.7 times higher than the average. Taking this average for the population as a score of 100, fifth and subsequent babies had a perinatal mortality of 154 but where the mother was of social class 5 (the poorest group) this rose to 198 or almost twice the expected rate. Here, two risk factors, higher parity and lower socioeconomic level, combined to give a higher risk.

Perinatal death rates for four risk groups in the same survey are shown in Table 2. While breech delivery led to an increase in perinatal deaths from nearly all causes, the effect of severe pre-eclampsia was an increase in antepartum deaths and deaths from perinatal hypoxia.

In the Jerusalem Perinatal Study[2] the combined stillbirths-neonatal death rate was 21.9 per 1000 but more than doubled, to 52.2, where the mother was aged 40 or more. When there had been a previous stillbirth, the mortality was more than five times higher than expected, while diabetes or toxaemia during pregnancy led to a similar increase in risk.

A more precise study in Prague[3] differentiated between prematurity and "small-for-dates" in low birth-weight infants (Table 3). Some maternal factors, such as toxaemia of pregnancy, renal disease, or previous sterility, were risk factors for both groups, although of different weights. Youth of mother was a factor in prematurity only, while short stature increased the chances of having "small-for-dates".

For practical purposes it is often feasible to design an intervention programme on the basis of limited but meaningful information. If more precise data are required, however, there is no alternative to a detailed study of outcomes and their correlates in a total population or, at least, in a representative sample.

2.3.4 Development of a scoring system

The purpose of a scoring system is to permit the classification of individuals or groups into different risk categories, those with the highest score being at greatest risk for the defined outcome. The simplest method is to allocate an ad hoc number of points for each characteristic, based on experience. For example, for poor outcome of pregnancy generally, the PAHO/WHO system[4] allocated up to three points for a poor medical

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[1] Butler, N.R. & Bonham, D.G., Perinatal mortality. Edinburgh, Livingstone, 1963 (first report of the British Perinatal Mortality survey).

[2] Davies, A.M. & Harlap, S., Antenatal prediction of peri- and neonatal mortality risk. Unpublished WHO working paper prepared for the consultation on identification and assessment of high risk for development of intervention strategies in maternal and child care including family planning (MCH/WP/HR/74.1).

[3] Stembera, Z.K. Factors influencing length of gestation and fetal growth (aetiology of low birth weight). Unpublished WHO working paper prepared for the meeting on etiology, prevention and social implications of low birth weight. Geneva, 1975 (MCH/LBW/WP/75.3).

[4] Prindle, R.A. & Gomez, C.J. Identification of maternal risk by the PAHO/WHO system. Washington, DC, 1973 (unpublished document).

Table 1

RISK FACTORS FOR MATERNAL AND PERINATAL MORTALITY AND MORBIDITY AND THEIR RELATIVE "WEIGHTS"

Risk factor	Danger to mother	Danger to fetus
Heart disease	high	low
Rubella in first trimester	low	high
Breech extraction	low*	high
Prolonged pregnancy, 294 days	low*	high
Multiple pregnancy	low	high
Prolapsed cord	low*	high*
Severe anaemia (5g Hb/ml)	high	high
(Pre-) eclampsia	high*	high*
Cephalopelvic disproportion	high*	high*
Placenta praevia	high*	high*
Malaria	low to high	low to high
Abruptio placentae	high*	high

*Risk increased when obstetrical care absent or poor.

Table 2

PERINATAL DEATH RATES BY CAUSE IN FOUR HIGH RISK GROUPS: ALL BIRTHS ENGLAND, SCOTLAND, AND WALES, MARCH 1958[1]

	Percentage of all births	Perinatal mortality rate per 1000							
		Congenital abnormality	Antepartum deaths	Perinatal hypoxia	Birth trauma	Immaturity	Infections	Other	All
Mother, parity 4+	8.9	7.4	9.6	12.6	5.5	4.1	2.4	10.2	51.8
Father unskilled	9.3	8.4	6.8	9.9	3.3	4.1	2.1	7.6	42.2
Severe pre-eclampsia in pregnancy	5.6	6.1	26.5	18.2	6.3	7.8	2.5	12.6	80.0
Spontaneous breech delivery	2.2	42.4	48.9	46.3	29.3	23.4	3.9	39.8	244.5
All births 3 to 9 March 1958 (Total = 16 994)	100.0	5.8	6.8	7.1	3.1	3.3	1.5	5.6	33.2

[1] From: Butler, N.R. and Bonham, D.G., Perinatal mortality. Edinburgh, Livingstone, 1963 (First report of the British Perinatal Mortality Survey).

Table 3

"WEIGHT" OF MATERNAL RISK FACTORS IN WOMEN DELIVERING LOW BIRTH WEIGHT INFANTS: COMPARISON BETWEEN "PREMATURITY" AND "SMALL-FOR-DATES"

Risk factor in mother	Frequency of risk factor compared to normal controls in	
	"prematurity"	"small-for-dates"
Age < 18	2.8	-
Previous induced abortion	1.8	-
Unmarried	1.8	-
Moderate to severe EPH gestosis (toxaemia of pregnancy)	1.7	3.0
History of renal disease	1.7	2.4
History of perinatal loss	1.7	-
Previous sterility	1.5	2.4
First trimester bleeding	1.4	2.0
Age > 30	1.3	1.2
Height < 155 cm	-	4.3
Mild EPH gestosis (toxaemia of pregnancy)	-	1.4
Pregnancy weight increase < 7 kg	-	1.4

Data from: Stembera, Z.K. Factors influencing length of gestation and fetal growth (aetiology of low birth weight). Geneva, 1975 (Unpublished WHO document MCH/LBW/WP 75.3).

and/or obstetrical history, up to three for high parity, and up to two for age (very young or very old). Additional single points are awarded if the birth interval is short, the family income low, or the woman unmarried and of poor education. Of a total of 12 possible points, women who obtain six or more are designated "high risk" and those with two or less "low risk". While this and other ad hoc systems are of use in calling attention to those women who may need special care in a given area, in other areas the weight of the risk factors might be quite different and require the allocation of different scores (see also Appendix 2).

The same principle has been proposed in one developing country to guide the primary health worker in referring pregnant women to the midwife. Women under 19 or over 40 are allotted four points, those 30 to 39 two points, and those 20 to 29 none. Similarly, those of parity ten or more receive four points, and primiparae one. Further points are given for short intervals between deliveries, a poor medical or obstetrical history, and low educational level. When the total points are five or more, the patient must be referred. With three to four points, referral is recommended when feasible. This implies that the referral policy will have to be determined locally.

A more accurate method, but one which requires preliminary studies, is to allot scores for each risk factor on the basis of measurements of the actual risks in the same population. Thus, in the study cited in section 2.3.3 a scoring system for women at risk for stillbirth and neonatal mortality could be computed by giving, say, two points for age 40 and over, five points for a previous stillbirth, and 1.5 points for the presence of a uterine scar from previous caesarian sections.

The most accurate approach would seem to be the allocation of scores based on combinations of possible risk factors, which are related to the defined outcome. Methods such as the analysis of variance have been used to derive such scores, which are then added together, for each set of factors, to give an overall estimate of risk. The value of scores obtained from such analyses may not be very different from those derived more simply, although there is, as yet, no objective evidence from studies in the fields of maternal and child care. However, a WHO working group on the methodology of multifactor preventive trials in ischaemic heart disease[1] used an ad hoc scoring method for defining the top 10% of risks (the high risk group) in the male population under study. On analysis, the crude scores have been shown to have much the same predictive value as more sophisticated approaches. The group felt that more work needs to be done, however, to develop methods of scoring.

It would be desirable to experiment with different ways of providing risk estimates, based on known values, for combinations of characteristics, e.g., high age and high parity with poor obstetric history, to test the usefulness of different scoring systems. For a limited number of factors, risks can usually be assigned to all possible category combinations. The scores, whatever the method chosen, are only useful to the degree that they permit the prediction of high-risk groups and outcomes in a prospective fashion and discriminate between levels of risk. It is thus necessary to test the validity of any scoring system.

2.3.5 Testing the validity of a scoring system

The crucial test of a scoring system is its validity: in other words, how good is the method in differentiating between those associated with an undesirable outcome and the rest of the population? In the statistical sense, validity is defined as "the extent to which a method provides a true assessment of that which it purports to measure".

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[1] WHO Regional Office for Europe. Report of a working group on Methodology of multifactor preventive trials in ischaemic heart disease, Innsbruck 1973, Copenhagen, 1973 (EURO 8202 (6)).

Fig. 1. DISTRIBUTION OF RISK SCORES IN THE POPULATION

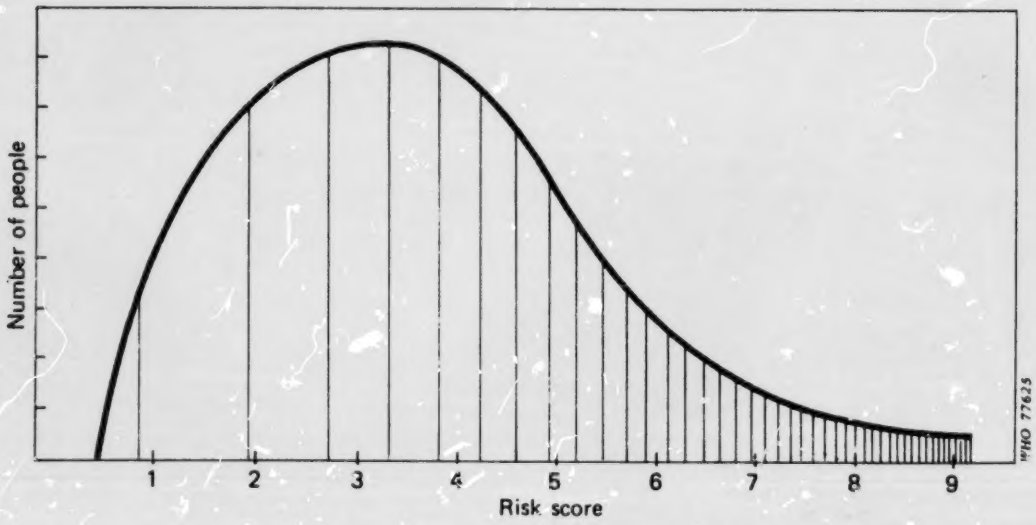
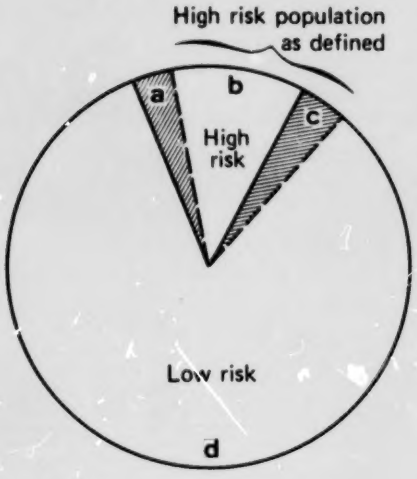


Figure 1 illustrates the distribution of risk in a population. The degree of risk increases from left to right. No one has zero risk, while a few have very high levels indeed. If an arbitrary risk scale is assigned as shown, then the group at risk could be defined as all those with scores of seven and above. Such a decision would lead to a high degree of specificity, most of those included would belong to the abnormal group although the sensitivity would be low, and many of those defined as low risk would be abnormal with lower scores. Sensitivity measures the ability of the method to encompass all those it is desired to include: the higher the sensitivity the fewer false negatives. Specificity measures the extent to which those it is desired to exclude are, in fact, excluded. In the example given, the sensitivity can be increased by reducing the cutoff point to, say, five, but only at the cost of reduction in specificity; that is, an increase in the proportion of false positives. The relationship between sensitivity and specificity in measurement is illustrated in Figure 2. Thus the final decision as to cutoff point must be a compromise between the two. For scoring of the kind considered here, the means available for prediction are not very precise and thus the values of both these measurements of validity are fairly low.

Fig. 2. SENSITIVITY AND SPECIFICITY IN DEFINING POPULATIONS AT RISK



a + b = High risk individuals

c + d = Low risk individuals

b + c = Those defined as high risk by the method used

$$\text{Sensitivity of method} = \frac{b}{a+b}$$

$$\text{Specificity of method} = \frac{d}{c+d}$$

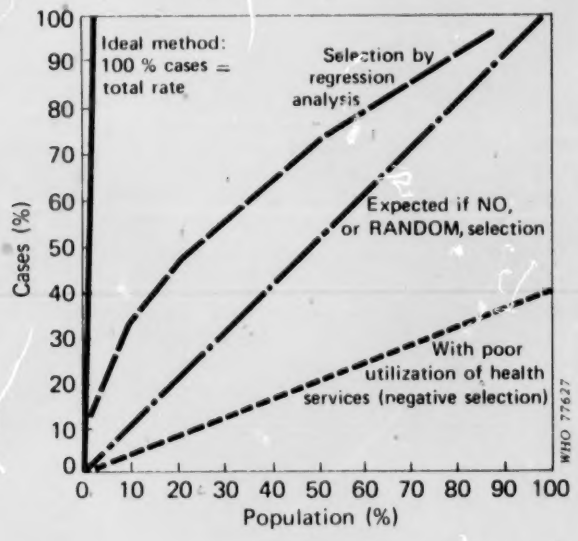
WHO 77626

The inverse relationship between sensitivity and specificity is affected by the frequency of the outcome to be predicted. In one study, when the combined stillbirth/neonatal mortality was over 90 per 1000, the sensitivity of a risk score based on 15 variables was only 16%. On the other hand, the specificity was 97% so that the prediction was correct in almost all cases. This low sensitivity would not have led to major misuse of resources as only 2.9% of pregnant women would be affected. Sensitivity and specificity rates at the 60% level identified 40% of the population (see Figure 3).

Fig. 3

EVALUATION OF PREDICTION METHODS FOR PERINATAL MORTALITY

(Model based on Jerusalem Perinatal Study data)



A similar result was obtained in the Prague study (see footnote 3, page 8) in which, using a score based on history and pregnancy risk factors, 85% of the cases of perinatal mortality were predictable in 48% of the population. When the threshold score was raised from ten or more points up to 30 or more, 40% of the perinatal deaths would be predicted in only 16% of the population. In other words, by raising the threshold, half the cases could be predicted for only a quarter of the work.

The decision how far to compromise between specificity and sensitivity will depend on the frequency of the outcome and, particularly, on the resources available for detection and treatment. To predict all cases of the stated outcome it will be necessary to examine all women.

A model of prediction of perinatal mortality, using a score based on 15 items of history and antenatal examination, is shown in Figure 3. Were the scoring method perfect, the "ideal predictor", then both the sensitivity and the specificity of the method would be 100% and 22 out of every 1000 pregnant women would be selected, all of them destined to lose their infants. All those with a low score would not be at risk. On the other hand, without any selection other than that of chance, the greater the proportion of women examined, the greater the number of cases detected: half the women would have to be seen to detect half the at-risk cases. Often the lowest line is seen, indicating negative selection; many high-risk cases are not detected because they do not use services, even when these are available. Finally, using a system for the computation of scores based on regression analysis of risk factors for this population, it is seen that the sensitivity rises sharply at first, with 10% of the population yielding 32% of the cases. Thereafter the scoring system becomes less efficient.

While it seems likely that similar kinds of results would be obtained even with different outcomes, other scoring systems, and different populations, this hypothesis will need to be tested in practice.

The kinds of risk factors scored in these examples include many of those given in Table 1 and in Appendix 2. The allocation of the scores, in turn, will depend on the validity of the measurement and recording of each factor. Inaccuracies in reporting and transcription will decrease the validity of the overall score. This point is important even when the score is to be based partly on laboratory data, such as haemoglobin or fasting blood glucose levels, where, again, the method carries its own inherent errors.

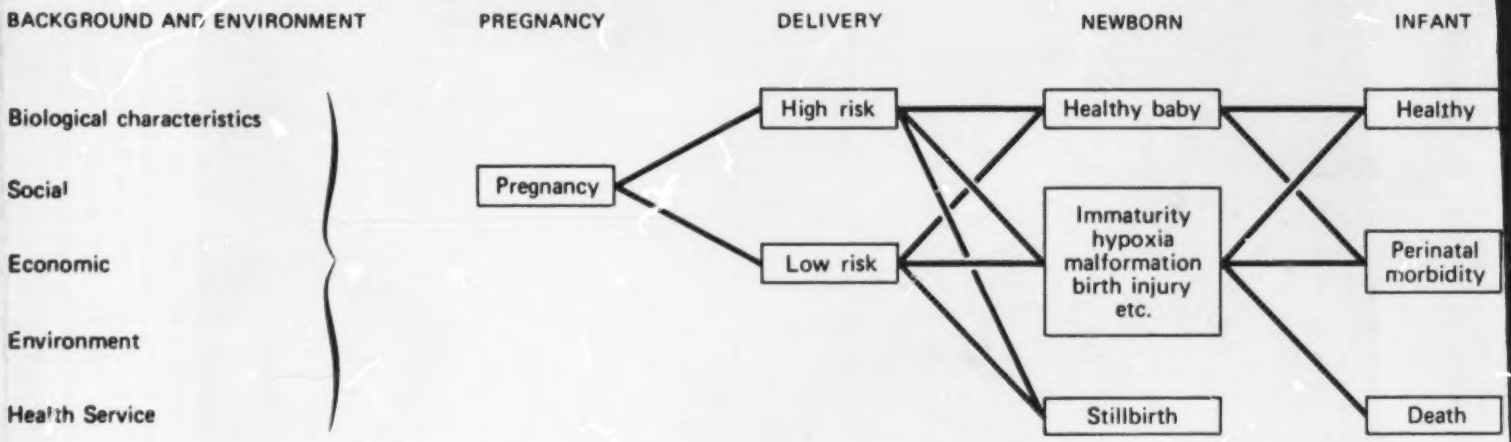
2.4 From risk measurement to intervention strategy

Figure 4 illustrates a very simple model of the choice of an intervention strategy based on risk classification, using perinatal mortality and morbidity as outcomes. It also indicates a more general approach, i.e. that it is necessary to seek intervention strategies outside the conventional health services, particularly where the risk factors have their origin in human behaviour or social organization.

Thus, in the present instance, pregnancy could be prevented (in, say, an older woman) or delayed (to permit spacing) by appropriate family planning activity. Nutritional supplements to pregnant women and to infants and schoolchildren are examples of other interventions directed to the reduction of perinatal mortality that could also have an effect on other defined outcomes. Identification of high-risk cases would follow the lines set out above, and intervention appropriate to the available resources would be undertaken. Special care at delivery, monitoring, and resuscitation may be possible in some countries with proper distribution of resources: in most it might require additional inputs as well as distribution of resources. Social action and environmental control action are of importance as points of intervention in maintaining the health of the newborn and preserving the life of the handicapped.

For intervention at an earlier stage we may consider the risk factor involved in fetal death before labour. The factors detected are based both on the history, including maternal characteristics, and on events during pregnancy. Examples of possible types of intervention are given in Figure 4.

Fig. 4. RISK FACTORS IN PERINATAL MORTALITY AND MORBIDITY AND EXAMPLES OF INTERVENTION



POINTS FOR INTERVENTION

e.g.	Family planning education social action nutrition overall risk	Identification of high risk cases and appropriate action (individual risk)	Special care	Monitoring resuscitation	Health care social action environmental control economic help rehabilitation

WHO 77628

	Risk factors	Examples of type of intervention*
History:	Age: under 17, over 35	General education for girls
	Unmarried mothers	
	Poverty and starvation	Availability of contraceptive advice
	Grand multiparity	
	Previous sterility or prolonged interpregnancy interval	Health care and health education before pregnancy
	Previous abortions	
	Previous perinatal deaths	Control of endemic disease
	Chronic infections (tuberculosis, malaria) and malnutrition	Nutritional supplementation and advice
	Pre-existing diabetes, hypertension or renal disease	Social security and labour laws
	High-risk employment	
Prenatal:	Vaginal bleeding: early, late (placenta praevia)	Early attendance for antenatal care
	Pre-eclampsia and eclampsia	Regular antenatal supervision
	Prolonged pregnancy	
	Poor weight-gain	Referral to hospital for, e.g., bleeding, diabetes, hypertension, prolonged pregnancy
	Diabetes, anaemia	
	Isoimmunization	
	Hydramnios	
	Viral infections	Special methods of diagnosis and fetal monitoring
	Signs of fetal hypoxia	
		Induction of labour or elective caesarian section

Examples of other outcomes, risk factors, and types of intervention are given in Appendix 2.

* The examples of type of intervention do not necessarily correspond to the risk factors listed in the first column.

3. MANAGERIAL IMPLICATIONS OF RISK APPROACH

The main objective of the at-risk approach is the optimal use of existing resources for the benefit of the majority. It attempts to ensure a minimum of care for all while providing guidelines for the diversion of limited resources to those who most need them.

Fig. 5. UNPLANNED UTILIZATION OF RESOURCES

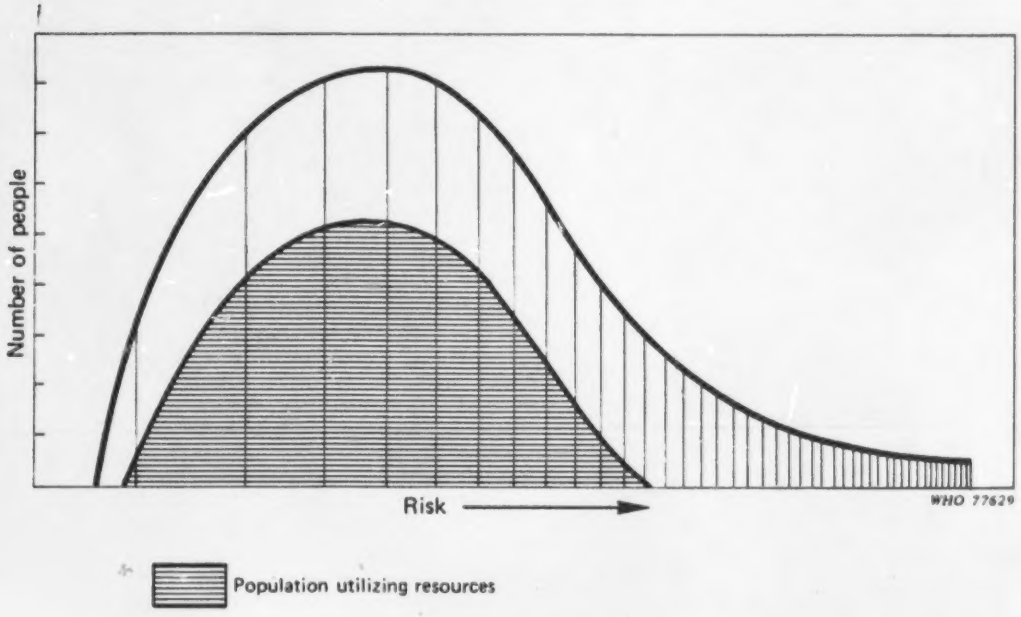


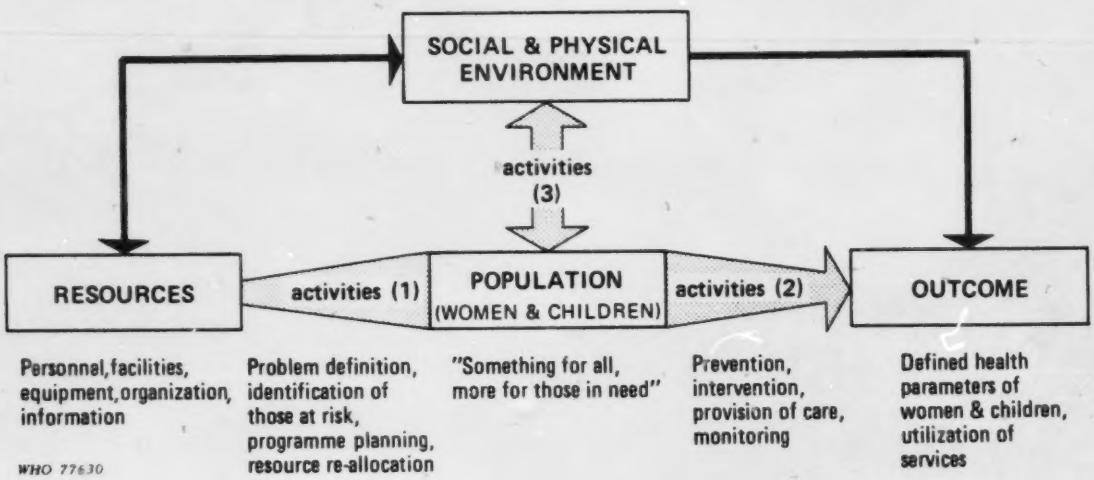
Figure 5 shows a common mode of utilization of resources by part of the population, self-selected by education, income, or influence or selected by place of residence and proximity to services. At best their risk scores are randomly distributed; more usually they contain disproportionately few high risk cases (see also Figure 3). Thus there is misuse of resources, with highly skilled personnel not using their special knowledge to the full and many who need their skills being excluded.

3.1 Development of strategy

Risk strategy may be defined as a social and health policy for active intervention based on valid data about costs, resources, risks of disease, and the effectiveness of different kinds of activity in different places. It is often called high-risk strategy to emphasize that the action rarely involves the whole vulnerable population and the fac that better definitions of risk groups are needed to decrease the size of the population receiving special attention. It is highly desirable, especially in the field of maternal and child health, that some minimal care be available for the total population. This will also make possible the detection of the high-risk groups and provide a data base for future evaluation.

By combining the experience derived from management of individual cases (clinical prediction) with epidemiological knowledge (community prediction), the concept of risk classification provides a frame of reference for better planning, programming, and administration of health services for mothers and children.

Fig. 6. MODEL OF MANAGERIAL STRATEGY FOR WOMEN AND CHILDREN


SOCIAL & PHYSICAL ENVIRONMENT
activities (3)
RESOURCES
activities (1)
POPULATION (WOMEN & CHILDREN)
activities (2)
OUTCOME
Personnel, facilities, equipment, organization, information
Problem definition, identification of those at risk, programme planning, resource re-allocation
"Something for all, more for those in need"
Prevention, intervention, provision of care, monitoring
Defined health parameters of women & children, utilization of services
WHO 77630

The model illustrated in Figure 6 shows a number of managerial implications of risk strategy, including stocktaking of resources and the organization of activities that will reallocate them to cover the total population on the basis of degree of risk and possibilities of intervention. The provision of services - activities (2) - is directed towards defined health parameters, and the efficacy of the measures taken is constantly monitored. The utilization of the services by those in need may be considered an intermediate outcome, and thus the proposed strategy also includes monitoring the utilization of the services. A basic implication for this activity, included here under resources, is the existence of a health information system.

The figure also illustrates the interaction between the physical and social environments, the population, resources, and outcome, to recall the need to develop intervention strategies - activities (3) - outside the personal health services. These include, for example, environmental sanitation, community development, adult education, and crop rotation, activities designed to raise the standard of living and thus reduce many risk factors.

3.2 Resources

Resources may be considered to include the following:

(1) Personnel, both trained and trainable. Potential resources will also include those outside the health care system who may be mobilized, such as traditional healers, women volunteers, teachers and agricultural extension workers.

(2) Facilities and equipment Apart from buildings and medical equipment, these include supplies of all kinds, transportation, and auxiliary services. Simple equipment, e.g., for measuring babies or for health education, can often be improvised with local ingenuity to meet local needs.

Two other items, which strictly speaking are activities, are of such fundamental importance as to warrant their being considered as resources. They are:

(3) Organization, or the ability of a manager to organize services and supplies effectively, including supervision, maintaining discipline, and facilitating referral where necessary.

(4) Health information system At its simplest, this would mean a rough census and a record of births and deaths but it would need to be extended rapidly to include such items as a register of pregnant women, complications of delivery, and morbidity in childhood. Attention should be paid to the possibility of linking the various records of members of the same family. The goal is an information system that would monitor the health of the population serviced, the use and efficacy of the services, and the outcome of intervention.

3.3 Activities

Activities are considered in more detail in the next sections. They include defining the population to be served, identifying major health problems, and selecting priorities. Next comes identification of risk groups (see Section 2) and the design of intervention strategies.

Inherent in the strategy is the mobilization of resources and their reallocation to meet the stated priorities. A necessary corollary is the need to make task analyses and job descriptions for the personnel involved and the establishment of training and retraining programmes (see Sections 4 and 7).

To sum up, the managerial goals of the risk approach are fuller coverage, optimal use of resources, upgrading and monitoring of MCH/FP services, and objective measurement of efficiency in terms of health improvement.

4. DEVELOPMENT OF LOCAL STRATEGIES

The establishment of MCH/FP programmes based on risk strategy requires an estimate of the importance of defined outcomes to the community, the feasibility of detecting those at risk with local resources, and the provision of facilities for intervention and referral.

These factors will vary considerably, taken singly or together, from place to place. The following points are therefore given merely as guidelines and a strategy will need to be developed in detail for each area and situation separately.

4.1 Local priorities

It will be necessary to take into account the frequency of different outcomes and the possibilities of intervention within the framework of local values and resources.

Strategies aimed, for instance, at reduction of the wastage of child life will, in different areas, have different local objectives. For some communities, perinatal mortality, for others, infants or toddlers aged 1-5 years will be the priority targets. Of the criteria related to the local situation which are likely to affect this choice of problems, only one is measurable in orthodox terms. The others must be estimated using rough scaling technique. The criteria are as follows:

(1) Desires of the local community (consumers' concern). Community participation in choosing priorities is essential in order that the services be in line with the needs of, and acceptable to, the local population. Perhaps one of the most difficult steps in planning health services is to have the full involvement of the community in decision making and in the choice of priorities. This will allow for consideration of health problems as perceived by the community and not only as seen by health workers.

(2) The frequency of the problem. For many parts of the world, information is available, for others it may only be anecdotal, especially in rural areas. For this reason, even rough sample surveys are of value in estimating prevalence.

(3) The seriousness of the problem. This is really an estimate or guess at social cost and may be unrelated to frequency. Man- or woman-years of expected handicap, pain, separation and grief, the value of life, the role of women and children, as well as economic loss to the community, are all involved so that cultural patterns are crucial.

(4) Availability of appropriate technology, both generally and in the specific situation.

(5) Effectiveness and efficiency, or the likely yield per unit effort. This could also be related to the expression of benefits and cost in a broad sense.

(6) Overall (national and regional) health policies and priorities including the health care system itself. These will often override local policy decisions.

4.2 Selection of outcome variables (problem selection)

Outcome variables will be of two kinds:

(1) Definable outcomes or biological indices which can clearly be related to known risk factors - perinatal death, low birth-weight, and failure to thrive are examples (see also Section 2.3.1).

(2) Service variables as indicators of the consumption of items of health care. These may be assumed to be related to family health and could include use of family planning by target populations, numbers of antenatal visits, and completion of infant immunization schedules. These may be regarded as intermediate outcomes.

By monitoring both the epidemiologically rigid and the service variable type of outcome, it will be possible to demonstrate progress even though the measured reduction in the "hard" outcome may not be significant within a short time.

4.3 Ranking of importance

It is necessary to rank outcome variables in some priority order for the development of strategy. Where a recording system for vital statistics exists, this may be done, in part, in numerical fashion. Where no such system exists, some estimates of frequency and importance may be obtained from the people themselves. One possible way would be to give arbitrary weighting (or scale the guesses) so that a rank order results. For example:

consumer concern	-	say, 5 points
prevalence	-	say, 20 points
seriousness	-	say, 10 points (medical and consumer opinion)
treatability	-	say, benefits (5 points) over costs (5 points).

These points can be added, if there is a wide range for each of the criteria, or multiplied in case of narrow range, to give a better grouping. Thus one expression might be:

$$\text{consumer concern } (1\text{-}5) \times \text{prevalence } (1\text{-}20) \times \text{seriousness } (1\text{-}10) \times \frac{\text{benefits } (1\text{-}5)}{\text{costs } (1\text{-}5)}$$

There are many disadvantages in combining such heterogeneous concepts, but on the whole the results of such an exercise should be helpful in priority formation. Outcomes or problems, ranked in this way, can then be re-examined in the light of local resources and general social policy. For more precise methods of measuring the weight of risk factors, see Section 2.3.4.

4.3.1 Identification of risk factors

The risk factors to be identified and, as far as possible, quantified should comprise both those considered to be of universal application and those of specific importance for the outcomes of special local interest.

Information needed for decisions on strategy includes both community factors based on population data (or best estimates) and individual factors for the pregnant woman and her family. The following are examples:

(a) Community factors

- Marriage and family formation patterns
- Cultural patterns, special taboos, and religious practices
- Education of women, their status and employment outside the home
- Economic patterns - socioeconomic indices (i) generally, and (ii) of defined sub-groups
- Nutrition, dietary habits, and availability of foods
- Age-distribution of pregnant women
- Parity distribution - spacing, birth order
- Fetal and child loss
- Environmental sanitation
- Prevalent infections and other endemic diseases
- Acceptability and utilization of available MCH/FP services

(b) Individual factors

- Education
- Age
- Parity
- Obstetrical history
- Previous fetal and child loss
- Socioeconomic status (ethnic group)
- Nutrition
- Signs of dysfunction (breathlessness, oedema, pallor)
- Selected clinical measurements

4.3.2 Defining families and individuals at higher risk

It is possible to define at-risk families on the basis of geography (e.g., those in peri-urban areas) or environmental factors (e.g., high-density or shanty housing). If it is decided to base the strategy on individual outcomes, it will be necessary to contact each member of the vulnerable group once. The strategy then becomes one of screening a defined population for high-risk individuals, using methods commensurate with the resources (see Section 2.4).

The methods to be used, therefore, depend on:

- the specific outcome variables
- the general and local risk factors
- availability and level of training of personnel
- possibility of contacting each family

The following are examples of characteristics that define individuals and groups at higher risk:

Present before conception	At-risk individuals
Age	Less than 18, 35 years or over
Education	Illiterate
Parity	Nulliparous, 6-8 or more
Socioeconomic status	Poorest
Number of people/number of rooms	Greatest overcrowding
Previous fetal or child loss	One or more
Time since last delivery	Less than two years
General state of health	Cough, fever, other chronic disease
Arising during pregnancy	
Previous delivery complications	Complicated, required intervention
Vaginal bleeding	Any bleeding, excessive discharge
Pallor (haemoglobin)	Less than 100 g/l
Swelling of body, face	Pitting oedema
Weight	Poor weight or excessive weight gain
Blood pressure	130/80 or greater
Proteinuria	Positive (2+ or more)
Fetal position	Transverse or breech
Multiple pregnancy	Twins
Prolonged pregnancy	43 weeks or more
Occurring during delivery	
Length of first stage	Prolonged
Length of second stage	Prolonged
Degree of bleeding	Excessive
Birth attendant	Untrained
Characteristics of the infant	
Birth weight	Below 2.0 (or 2.5) kg
Breast/artificial feeding	Prolonged breast feeding without supplementation, early artificial feeding, inadequate feeding
Weight/age	Poor development
Health status	History of diarrhoea, no immunization

4.4 Description of community resources

Resources, as indicated in Section 3.2, comprise personnel and facilities, both current and potential. The success of the local strategy will depend on an understanding of the sociopolitical and administrative structures so as to ensure full collaboration at a number of levels. Thus, the information to be collected should include the following as far as it is relevant:

(1) A description of the agencies, health and other, that are relevant to the provision of health care, covering their structure, organization, and mode of working, including supervision and in-service training. In particular, details of the local health services must be obtained, including their staffing and referral patterns.

(2) Identification of health and health-related personnel in the community, in particular those concerned with MCH, with a description of their roles, activities, responsibilities, and training. This should include details of the chains of authority and command, together with an appraisal of willingness to cooperate and to alter current service patterns.

(3) Nature of the vital statistics being collected.

(4) Search for other providers of health care such as traditional healers and tribal midwives with an estimate of their status, role, and influence.

(5) Identification of decision-makers in the community who could expedite or hinder the new strategy. Attitudes of the people to the services and impediments to their utilization.

(6) Availability of untrained or partly trained personnel with health care potential such as high school graduates, traditional healers, or practical midwives who could be recruited and trained.

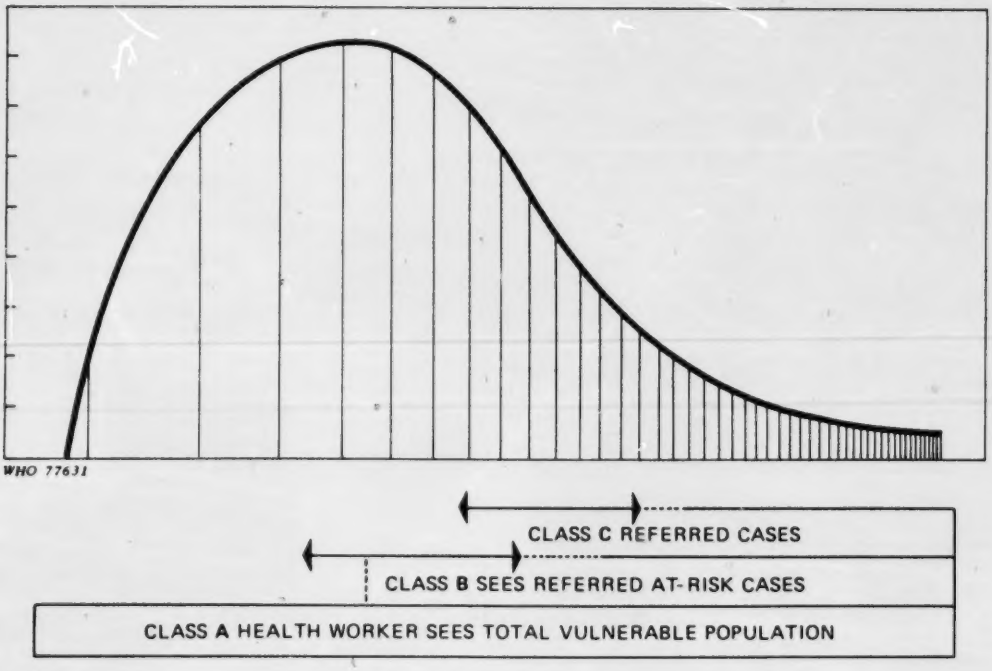
It may be useful to prepare checklists for the description and quantification of the resources to see how they can be committed, together with questionnaires to facilitate assessments of function.

4.5 Development of local intervention strategies

(1) Strategies will be determined by priorities and resources. For some risk factors, causally related to the outcome, intervention will be directed to reduction of the risk factor. For those which are indicators (e.g., poverty), the strategy will be to alert the service to further action, which may consist of examination, referral, increased surveillance, or a decision that nothing can be done. For yet other factors, such as widespread malnutrition and anaemia, the need will be for social action beyond the usual boundaries of health care.

(2) Scrutiny of the information gathered, as mentioned above, will, in the light of the risk factors identified, indicate what is available and what can be redeployed. Decisions, based on a rough estimate of costs and benefits, priorities, and the size of the problem, should be made on the basis of a resource allocation model. As indicated in Figure 8 and in Section 7, the model should be sequential and require constant changes in the light of the evaluation and re-evaluation of test programmes.

Fig. 7. MODEL OF RESOURCE ALLOCATION AT THREE LEVELS OF TRAINING


WHO 77631
CLASS C REFERRED CASES
CLASS B SEES REFERRED AT-RISK CASES
CLASS A HEALTH WORKER SEES TOTAL VULNERABLE POPULATION

(3) A basic model, for individual risk with three levels of resource allocation, is shown in Figure 7. The basic attribute is that the primary health worker (class A) sees all members of the vulnerable group in order to detect at-risk cases at a level and according to a method elaborated for local use. Cases detected are then referred to the next level of health care, the cutoff point being determined by local conditions. A few cases, of the highest risk, may be referred further (class C).

In the simplest form, the traditional midwife or healer will screen, say, all pregnant women and refer those at risk to a trained midwife who, in turn, might send those in greatest danger to a health centre or physician.

Where trained manpower is not so limited, the class A worker can herself be a trained midwife, referring a greater percentage of the at-risk cases to a physician who is, in turn, backed up by obstetrician or hospital as class C.

The above is an example of a particular resource allocation procedure which may be applicable in some areas. The detailed allocation method adopted will need careful planning in each area separately as stated above.

(4) Ways of intervention at different resource levels are illustrated further by the examples in Appendix 2. One important problem, which may affect the acceptability of the strategy, is that of providing services and being seen to provide services from the beginning, while the definitive local strategy is being evolved.

One approach to this problem is to select one risk factor known to affect several outcome variables. One example is high parity, associated with maternal morbidity and mortality, low birth weight, perinatal mortality, and increased chances of congenital malformation and childhood handicap. The condition is simple to detect, the cost of detection is low, short-term intervention may be feasible, and long-term prevention, by family planning, possible. The decision as to what constitutes high parity is, again, a local one, depending on resources for detection and referral.

Another approach would be to list those 8-10 risk factors which a priori would appear to affect the health of mothers and children most. The selection of these would be based at first upon the notion of highest yield in resource reallocation. The methodological problems are to define those factors in respect of which intervention will be productive, to find the families concerned, and to reallocate resources (Appendix 2).

A more detailed discussion of the implications of these and other strategies is given in Appendix 3.

4.6 Monitoring and evaluation

A basic principle of the at-risk approach is that the strategy should be explicit and its value measured. Improvements in the biological indices (Sections 2.3.1 and 4.2) may not be apparent for some considerable time so that statistical proof of the value of the new intervention strategy will not be readily available. It might be possible, however, to demonstrate a reduced frequency of undesired outcomes in defined subgroups, such as fewer obstetric deaths or a lowering of infant mortality in children of grand multiparae, consequent on a reduction of the number of high parity pregnancies. Further examples would be the reduction of neonatal tetanus by the immunization of pregnant women and an increase of birth weight by treating maternal malnutrition.

The incorporation of service elements (Section 4.2) as intermediate outcome variables improves the chances of demonstrating success. These would include, for instance, the proportion of women seen during pregnancy and the stage at first contact, the number of contacts for child care, the proportion of infants completing immunization schedules, and the number of fertile women practising family planning. It is reasonable to assume that service variables such as these will affect the health status of the family and, over time, produce the "hard" data necessary for epidemiological assessment. Further details are given in Appendix 2.

5. DECISION PATHWAYS FOR SELECTION OF INTERVENTION STRATEGIES

Priorities for intervention will be selected locally on the basis of a number of criteria. These will include inter alia prevalence, severity, importance to the community, feasibility of change, and predicted costs and benefits (Section 4). The results of this selection process may be a single outcome or, most probably, a group of conditions that represent the unfavourable results of the processes of reproduction, growth, and development that are to be ameliorated by the new MCH/FP service.

5.1 Example of a decision pathway

This section gives an outline of one possible systematic approach to the selection of intervention strategies based on defined outcomes, risk factors, resources, constraints, and manpower and presented as a series of decision steps. There are, doubtless, several approaches[1] and the following is but one of them. Because of the great variations in the frequency and importance of different outcome variables in different localities, as well as the wide difference in risk groups, resources, and possibilities for intervention, only rough guidelines can be given. The examples chosen to illustrate the principles are perinatal mortality and infant-toddler mortality, both, unfortunately, common and widespread.

(1) Define outcome variable(s), based on frequency and importance to the community - in the present example, perinatal mortality and infant-toddler mortality.

(2) List associated causes and their frequency. As an illustration, data have been taken for perinatal mortality based on Barron's series from Makassar Hospital, Indonesia,[2] and for infant-toddler mortality from Morley's findings from Nigeria.[3]

The detailed findings from these two studies are given in Appendix 1. For the perinatal mortality, Barron lists five main associated causes. These are: low birthweight (accounting for 36% of his cases); birth trauma (18%); fetal anoxia (13%); antepartum haemorrhage (10%), and congenital malformations (9%). The relative frequency will, of course, differ with the country and the locale.

(3) For each of these associated causes, list precursors and risk factors based on local conditions, and allot scores. This may be done approximately by local consensus or special surveys may be needed. The list given in Appendix 1 is a composite of known risk factors.

(4) For each risk factor or precursor decide:

(a) the possibility of influencing outcome using available health technology with an estimate of expected change under optimal conditions;

(b) the methods needed for measurement (for instance, detection of low birthweight requires scales and the presence at the birth, or shortly thereafter, of someone trained in their use); fetal anoxia may be detected by use of Apgar scores, but this implies a certain standard of obstetrical care;

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[1] Bainbridge, J. & Sapirie, S. Health project management. Geneva, World Health Organization, 1975 (Offset Publication No. 12).

[2] Barron, S.L. Perinatal mortality and birth weight in Makassar, Indonesia. J.Obstet.Gynaecol.Br.Commonw. 81:187-195.

[3] Morley, D. Paediatric possibilities in the developing world. London, Butterworth, 1973 (Postgraduate Paediatrics Series).

(c) the feasibility, including the acceptability, of each particular intervention in the specific community, still without consideration of costs. As an example, family planning would be the desired intervention in reducing pregnancies in women over 35. It would be theoretically 94-99% efficient, depending on the method used which would, in turn, be affected by community attitudes. In some cultures, this intervention would be unacceptable.

(5) For each risk factor or precursor compute the type and extent of the input needed for community intervention. In the above example, this would require contacting all women of fertile age in the community and the provision of contraceptive advice for the older groups. This step requires knowledge of population size and distribution and a decision as to the method to be used.

(6) For each input, calculate the resources needed. This will include an estimate of the skills needed and the time taken for each task. From a practical point of view, it would be desirable to distribute the needed resources among three levels of personnel. For example, if it has been decided to use contraceptive steroids, the pills could be distributed by the first level of local health workers (class A), e.g. traditional health workers in one community, midwives in another. On the other hand, if the IUD is the method of choice, this would have to be inserted by a more skilled person (class B) with possible referral of some of the difficult patients to the most skilled (class C). The actual level of skills would again vary from community to community (see Section 4.5(3) and Figure 7). Sum up the total resources needed for all interventions.

(7) Measure the available resources, particularly in terms of manpower and skills, and compare these with those needed. At this stage, it will be necessary to consider alternative strategies, perhaps using less trained health personnel. In the family planning example, the absence of practical midwives capable of inserting the IUD could lead to a decision to switch to contraceptive pills, or to train otherwise unskilled personnel to insert the IUD.

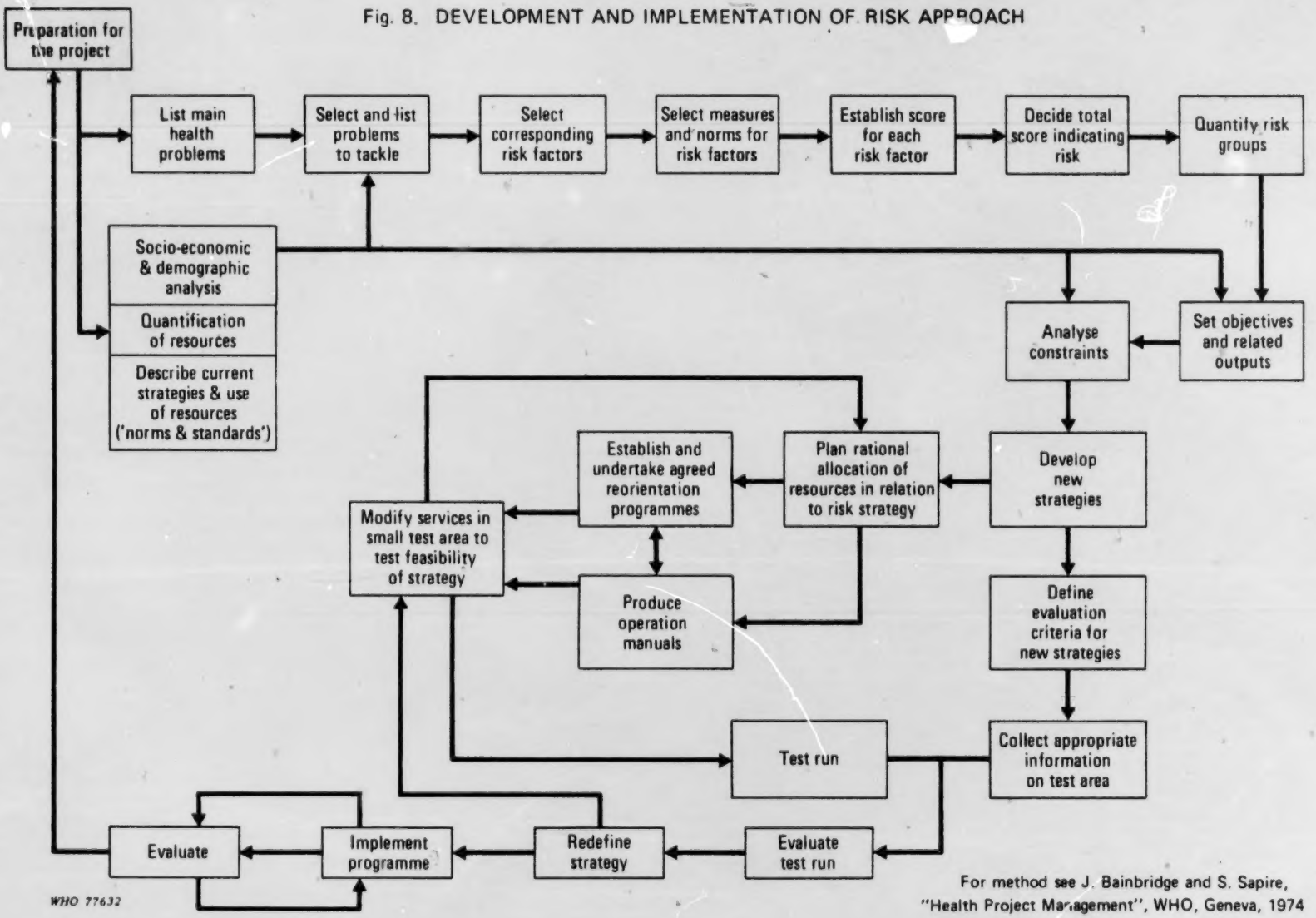
(8) On the basis of all these considerations, for each type of intervention make final decisions as to the overall strategy to be employed. Where one type of intervention, e.g., family planning for women over 35, will affect several risk factors, for example, perinatal mortality, low birth weight, fetal anoxia, and congenital malformations, then in a situation with limited resources this would receive higher priority. Where risk factors are universal, some interventions will include every woman and child. Where they are confined to certain sections of the population, the overall strategy must include provisions for minimal care for all, including those apparently not at risk.

5.2 Supplementing and monitoring the intervention strategy

For each field operation it will be necessary precisely to define, in operational terms, the tasks to be performed at each stage, who will perform these tasks, how they will be performed and when. In short, it will be necessary to write a detailed operations manual which can form the basis for instruction and evaluation.

A flow chart, illustrating the steps for developing, implementing, and testing the risk strategy is given in Figure 8. The main factors, in addition to the steps outlined in previous sections, are the definitions of criteria for the evaluation of each new strategy and the field trial (test run) followed by modification, retesting, and re-evaluation until a satisfactory strategy is achieved. This component of monitoring-evaluation-improvement is an essential and distinguishing feature of risk strategy for mothers and children.

Fig. 8. DEVELOPMENT AND IMPLEMENTATION OF RISK APPROACH


Preparation for the project
List main health problems
Select and list problems to tackle
Select corresponding risk factors
Select measures and norms for risk factors
Establish score for each risk factor
Decide total score indicating risk
Quantify risk groups
Socio-economic & demographic analysis
Quantification of resources
Describe current strategies & use of resources ('norms & standards')
Analyse constraints
Set objectives and related outputs
Establish and undertake agreed reorientation programmes
Plan rational allocation of resources in relation to risk strategy
Develop new strategies
Modify services in small test area to test feasibility of strategy
Produce operation manuals
Define evaluation criteria for new strategies
Test run
Collect appropriate information on test area
Evaluate
Implement programme
Redefine strategy
Evaluate test run
WHO 77632

For method see J. Bainbridge and S. Sapire, "Health Project Management", WHO, Geneva, 1974

6. HEALTH INFORMATION

Information is necessary for planning, implementation, and evaluation so that an information system is an integral part of at-risk strategy. Vital statistics or at least reliable estimates are essential, as is an assessment of community ecology, although it should be possible to begin to improve services without waiting for precise information or research. The need for information on resources and the workings of the health services is referred to in Section 4.4.

6.1 Basic information for planning

Wherever possible the health information system for each defined area should include the following:

- vital statistics, age-sex distribution of population, fertility, birth rate, mortality by age and sex (and by cause, if known), and marriage patterns;
- geographical distribution by community and households;
- area maps and communication facilities, and climate;
- cultural patterns, occupations, religious customs, and attitudes to health, disease, family planning, and child rearing;
- educational facilities and educational levels of population;
- environmental sanitation, water, sewage, flies, rodents, and other disease vectors;
- community organization, identity of religious and lay leaders, and administrative patterns (Section 4.4);
- major health problems, especially in the MCH field, of concern to local population (Section 4.3.2);
- health services, organizations, availability, distribution by numbers and qualifications of personnel and facilities, acceptance and utilization patterns, and presence of traditional healers (Section 4.4).

When some of this information is unavailable or unsatisfactory, special surveys might be undertaken or estimates derived from knowledge of local conditions. As before, this list is merely a guideline which may need modification to suit a particular situation.

6.2 Information to be collected routinely

In addition to the above, it will be necessary to make and maintain regular contact with all households in the service area to detect pregnancies and to monitor those aspects of health and morbidity that are of relevance to the chosen strategy. These will usually include information on live- and stillbirths and infant deaths and some forms of morbidity recording.

The following systems of collecting information have proved satisfactory in practice:

(1) A list of households and household members, by age and sex, is prepared. Where the number of midwives, nurses, or auxiliaries is adequate, each of them is allotted a defined area and begins to visit the households in a systematic and regular fashion. The lists help the health worker and facilitate supervision of her work. During her visits, in addition to her routine duties, she updates the lists and records births and deaths.

(2) Community contacts may be recruited from village or neighbourhood residents to assist when there are not enough trained personnel to cover the whole population. These contacts inform the health worker about pregnant women, births, and deaths in their assigned areas. When pregnant women are identified they may be referred to a midwife, depending on re ources, or allocated to a risk group by the community contact and followed up according to local practice as laid down by the strategic plan. The same principles apply to infants delivered to women not under health care. According to circumstances, other data may be collected and recorded by the community contacts.

(3) Service statistics of utilization of health care facilities by women and children will be compiled from the records, which should be maintained for each individual. The records, which should be simple and straightforward, may be retained by the health worker, community contact, or mother and will contain entries relevant to the intervention strategy. These may include the stage of pregnancy at first visit, number of antenatal visits, details on the delivery and the birth attendant, birth weight and sex of the newborn, items of growth and development, and immunizations given. For non-pregnant women, details on family planning practice should be noted.

In addition to this individual record, the family lists of the health workers or community contacts and their diaries of their activities provide an important record of service activity.

6.3 Statistical summaries

These should be prepared by the health worker, community contact, or supervisor weekly or monthly and quarterly. They provide valuable information on the degree of coverage of vulnerable groups, of outcomes, and of interventions and their results. Continuous monitoring of this kind and the feedback of the summaries to those who collect the data are an important part of training and of the supervision and evaluation of the programme.

7. IMPLEMENTATION AND EVALUATION OF THE RISK APPROACH

The establishment of an intervention programme employing risk strategy must be based on the fact that the disease or outcome forming the target is important in terms of frequency and severity both on general grounds and in the eyes of the society concerned. The assumption is made that ascertainment of individuals and groups at risk permits specific and more effective intervention ("earlier is better"). It is also assumed that reduction of risk factors is feasible and leads to a reduction in disease or undesired outcomes. Much of the evidence for these assumptions is indirect and derived from control programmes for infectious diseases and the analysis of factors subject to temporal change in some industrialized countries.

The concept of the risk approach, as described in this report, logically should improve resource allocation and efficiency and effectiveness of MCH/FP services. However the practicability and usefulness of this approach in various settings have to be evaluated through field application.

To this end, it will be necessary to select a number of defined areas, with different health problems and with different levels of resources, in which field trials can be mounted. It is desirable that the indices of health and of service utilization selected for study be sensitive enough, and the methods of intervention robust enough, to show significant changes within a limited time period.

7.1 The objectives of the field studies

The overall objectives of the collaborative field studies would be to develop a practical methodology for the assessment of levels of risk in individuals and groups of individuals and for the development of local risk strategies by matching levels of risk to levels of resources, and to test their efficiency and effectiveness in various settings.

The specific objectives are:

(1) to define the maternal and child health problems of major concern to the populations of the particular areas (Sections 4.1, 4.2, 5.1);

(2) to develop instruments of local applicability in order to estimate the size and severity of the problem(s), the capabilities of local resources, the risk factors involved, and approaches to their detection (Sections 4.4, 5.1);

(3) to develop a local strategy of intervention based on risk factor detection and leading to improved coverage (Sections 4.5, 5);

(4) to monitor the outcome and review the results (Section 4.6);

(5) to reassess the problem and the approach in the light of implications for local and general resource allocation and health manpower policy, particularly the deployment of health personnel at the lowest levels of training (Figure 8).

It was the firm view of the task force that there should be no research without service and thus the establishment or development of service facilities would be an intrinsic part of the objectives, even if it was not essential for the study itself.

7.2 Operational requirements for monitoring field studies

It will be necessary, for each field study, to define precisely, in operational terms, the tasks to be performed at each stage, who will perform these tasks, and how and when they will be performed. In short, it will be necessary to write a detailed operations manual that can form the basis for instruction and evaluation.

In Appendix 3 is presented an example of a first expansion of the general objectives, using maternal anaemia as the risk factor and birth weight, perinatal mortality, and growth and development as the outcome variables.

The purpose is to illustrate some of the steps in bridging the gap between concepts and action. In each situation it will be necessary to produce detailed protocols. Appendix 1 presents a broad example of the kind of thinking on which these must be based.

7.3 Considerations in selecting sites and outcomes for trial

(1) The selection of one or two outcomes, common to all sites, is recommended in order to permit the comparison of results achieved in different areas and based, presumably, on different strategies. Examples include perinatal mortality, low birth weight, infant gastroenteritis, and childhood accidents. It is essential that the outcomes selected be of importance to all areas although their priority ranking might differ from place to place.

(2) The size of populations to be studied will depend on the need for evaluation and be influenced by the outcomes selected and their frequency. If, for instance, an attack is to be made on perinatal mortality with an initial rate of 40-50, then it would be desirable to obtain, say, 200 cases, i.e., apply the strategy to 4000-5000 pregnant women (see Appendix 2).

(3) The duration of trials of the methods should be as short as possible but they will probably take three years at least. This, again, will depend on the frequency of the outcome selected, the availability of personnel, the speed of development of the strategy, and the quality of the data.

(4) The geographical areas of the study should be chosen by the countries concerned, in collaboration with the World Health Organization and in the light of the constraints listed below. Although not essential, it is desirable that studies in different areas be run concurrently. It is recommended that at least three different cultural groups in as many continents be studied, that they be at different stages of health service development and that one of them be in a peri-urban area.

(5) Comparisons between different projects in different areas will need to be made using rigorous scientific methods. The difficulties in this type of study are considerable but may be alleviated, in part, by standardization and coordination. It should be possible to use adaptive, sequential designs in which modifications to projects in one area may be made on the basis of accumulating results from that and other areas. Such a scheme, properly devised, can be analysed to give rapid and valid results.

(6) Criteria in selecting areas include the following:

- area not too remote or inaccessible;
- minimal data available on population, e.g., census, vital statistics, or the possibility of obtaining such data without undue difficulty (Section 5);
- presence of some minimal health services and the possibility of developing these to permit contacting every woman - in other words the possibility of full coverage, even if the primary health worker has only minimal training;
- enthusiasm of the local community, wholehearted support of authority, and full collaboration of all health and social services;
- no bar to the use of services, i.e., services should be available free;
- relative political stability;
- feasibility of integration into national health plans;
- local resources that, even if limited, can be reallocated and the possibility of carrying the study through with few or no added resources, except for training facilities.

APPENDIX 1

Further examples of risk factors, scoring systems, and intervention strategies

As illustrations, a few examples relating to different levels of intervention are presented in more detail.

1. Perinatal mortality

The distribution of associated causes is based on Barron's series from Makassar Hospital, Indonesia.[1] With extensive resources it may be possible to differentiate between low birth-weight groups, true prematurity and "small-for-dates" and refine intervention strategies still further.

Associated causes	Precursors and risk factors	Possible interventions
Low birth-weight (36%)	Mother aged under 17, 35 or more Low prepregnancy weight Poor maternal weight gain Grand multiparity Short interpregnancy interval Previous pregnancy loss Multiple pregnancy Vaginal bleeding Pre-eclampsia Previous induced abortion Chronic infection Smoking	Improved health education before pregnancy Contraceptive advice Improved nutrition Early and regular antenatal care Referral for bleeding, multiple pregnancy, cervical incompetence, pre-eclampsia, etc. Rest during pregnancy Cessation of smoking Intensive care during labour Resuscitation of newborn
Birth trauma (18%)	Cephalopelvic disproportion Previous babies over 4 kg Previous operative deliveries Breech delivery High forceps Unattended labour	Careful obstetrical history Early and regular antenatal care Early referral Delivery by qualified attendant
Fetal hypoxia (13%)	Mother over 35 Maternal malnutrition Grand multiparity Maternal obesity Previous perinatal death Anaemia Endemic diseases, e.g., malaria Poor weight gain Prolonged pregnancy Vaginal bleeding Pre-eclampsia Chronic diseases, e.g. cardiorenal Transverse lie Breech delivery Prolonged labour Prolapsed cord Placenta previa Second twin	Improved health education before pregnancy Contraceptive advice Improved nutrition Control of malaria Early and regular antenatal care Referral for treatment of specific complications and diseases Delivery by qualified attendant Possible induction of labour, or caesarian section Intensive care during delivery Resuscitation of newborn

[1] Barron, S.L. Perinatal mortality and birthweight in Makassar, Indonesia. J.Obstet.Gynaecol.Br.Commonw. 81:187-195.

Associated causes	Precursors and risk factors	Possible interventions
Antepartum haemorrhage (10%)	Trauma Pre-eclampsia Hypertension Premature labour Twin delivery Version Breech delivery	Antenatal care with early detection Referral for specific treatment and delivery under qualified supervision Possible caesarian section Resuscitation of newborn
Congenital malformations (9%)	Mother aged over 35 Consanguinity Rubella during pregnancy Teratogenic drugs etc.	Improved health education Premarital and family counselling Contraceptive advice Immunization against rubella

2. Infant and toddler mortality

The distribution of associated causes is based on Morley's data from Nigeria.[1]

Associated causes	Precursors and risk factors	Possible interventions
Protein-calorie deficiency (12%)	Illiteracy Mother working away from home Lack of breast feeding Poor feeding patterns Failure to thrive Short interpregnancy interval Diarrhoea Measles Pertussis	Community action to improve food supply, education of girls, facilities for the care of babies of working mothers, health education for personal hygiene Contraceptive advice, well-baby care including feeding advice and immunization
Pneumonia (12%)	Upper respiratory infection Diarrhoea	
Diarrhoea (12%)	Artificial feeding Malnutrition Polluted drinking water Flies Inadequate disposal of faeces Poor personal hygiene Dehydration Measles	Early detection and care of sick infants, provision of safe drinking water, hygienic disposal of excreta, garbage, and waste water
Measles (8%) Pertussis (8%)	Source of infection in community Malnutrition Overcrowding	

[1] Morley, D. Paediatric priorities in the developing world. London, Butterworth, 1973 (Postgraduate Paediatric Series).

3. A simple scoring scheme for pregnancy risk

The following scheme, developed from the PAHO/WHO system (Section 2.3.4) for a North African country is applicable to nonpregnant women, for priority in family planning, and to women in early pregnancy, for risk allocation. It can be administered by untrained personnel and should be modified in the light of local conditions and availability of resources.

	Characteristics	Points
Age	Under 19, over 40	4
	Between 30 and 39	2
	Between 20 and 29	0
Number of children	10 or more	4
	0 to 1	2
	2 to 9	0
Interval between deliveries	Less than 24 months since last delivery	1
	24 months or more since last delivery	0
Medical history	Previous obstetrical complications, perinatal deaths, etc.	3
	Diabetes, heart disease, renal disease, psychoses, etc.	5
Maternal education	Illiterate	1
	Can read and write	0

The points are added up to give a total score and decisions taken as follows:

1.	Highest risk, referral obligatory	5 points or more
2.	High risk, referral recommended	3 to 4 points
3.	Usual risk, usual local care	0 to 2 points

4. Sophisticated scoring systems for pregnancy outcome risk

The two examples that follow derive from analyses of the variance of stillbirth and neonatal death in relation to maternal characteristics in total defined populations. Their purpose is to give general guidance as to the risk of mortality for a singleton birth: however, the value of the score may be limited by the exclusion of certain factors that could be of importance in an individual case.

4.1 The British Perinatal Survey

The data are based on 16 994 singleton births in 1958 in Britain.[1]

Maternal characteristics	Groups	Score
Age	Under 35	- 138
	35 or over	138
Parity	0	29
	1, 2, 3	- 98
	4 or more	69

[1] Butler, N.R. & Alberman, E.D. Perinatal problems. Edinburgh and London, Livingstone, 1969 (Second report of 1958 British Perinatal Mortality Survey), chapter 3.

Maternal characteristics	Groups	Score
Social class	1, 2	- 84
	3	8
	4, 5	76
Height (in inches)	Under 62(=157 cm)	62
	62 or more	- 62
Pre-eclampsia	None to moderate	- 280
	Severe	280
Smoking habits	Smokers	85
	Non-smokers	- 85

The scores are added and then converted, by reference to a table, to an estimated stillbirth and neonatal mortality rate per 1000 total births. Thus a score of - 500 represents an estimated rate of 15.4, of zero a rate of 34.9, and of + 500 a rate of 65.5.

4.2 The Jerusalem Perinatal Study

The data are taken from an unpublished WHO working paper.[1] The analysis is based on 42 002 singleton births, 1966-72, and uses a method of regression analysis to give a combined score which is the predicted stillbirth neonatal mortality rate.

Maternal characteristics	Score
Basic score (all women)	15
Primipara aged 35 or more	22
Age 40 or more	22
Twin pregnancy primipara	133
" " multipara	40
Previous stillbirth	91
Previous child death	24
Diabetes	77
Pre-diabetes	28
Pre-eclampsia	77

5. Infant gastroenteritis

The following simple strategy, based on the health education of mothers by village workers, has met with success in at least one South American country.

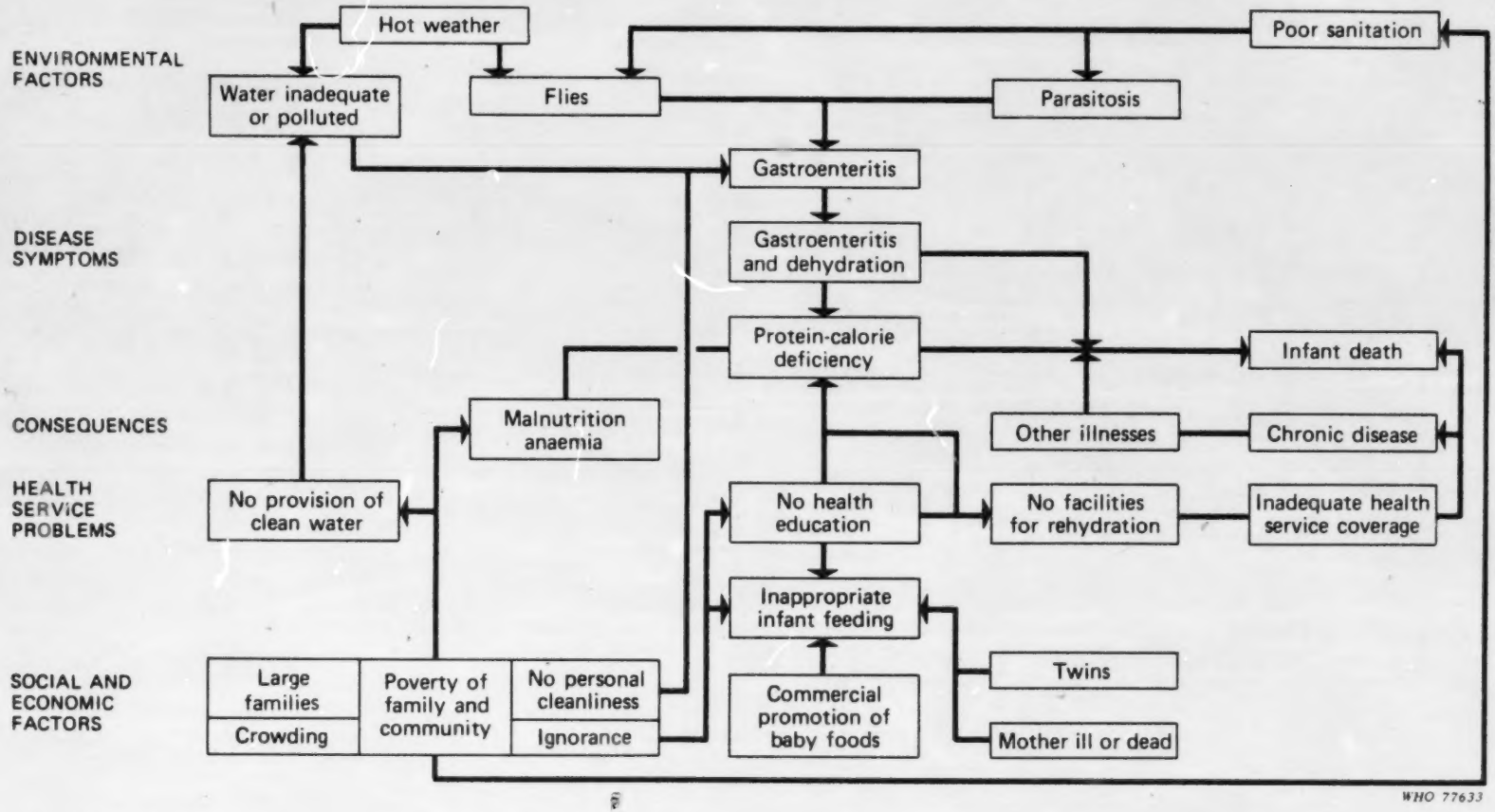
Risk factor	Intervention	Place and time	Who acts
Weaning	Correct supplementation	Local, before weaning	Mother, with encouragement
Hot weather	Keep baby cool	Local, summer season	Mother
Large family	Family planning	Clinic, post-puerperal	Village worker and midwife
Early diarrhoea	Give fluids	Local, early diagnosis	Mother and village worker

[1] Davies, A.M. & Harlap, S., Antenatal prediction of peri- and neonatal mortality risk. Unpublished WHO working paper, MCH/WP/HR/74.1.

6. Infant gastroenteritis: community interactive model

Any serious attempt to control gastroenteritis in infants cannot be limited to health services and must include improvement of the social, economic, and hygienic environments. Such an approach entails a multiple intervention strategy, as indicated in the attached interactive model.

COMMUNITY INTERACTIVE MODEL FOR CONTROL OF INFANT GASTROENTERITIS



Adapted from "Health Project Formulation: A Manual of Procedures" WHO/PSA/71. Rev. 2 Draft 2

APPENDIX 2

Notes on resource allocation and methods of evaluation

These notes deal with a number of theoretical, methodological, and practical problems associated with risk measurement and intervention.

1. Risk allocation: limiting factors

The various scoring systems outlined in Section 2.3 and in this appendix are based on the fact that although most risk factors are continuously (rather than discretely) distributed in the population, it is possible to allocate individuals to one of a number of exclusive categories.

Suppose we consider maternal age and parity as risk factors for perinatal mortality and define two groups for age and two for parity. There are then four combinations, each of which carries a measurable risk for the outcome, and they may be ranked in decreasing order of risk. When the number of factors is increased or the number of groups for each increased, then the ordering into risk categories becomes complicated and requires a more complicated scoring system.

However, the best scoring system will only identify a proportion of the cases at risk: the better the system, the smaller the proportion of the population in which they are found. In a study of infant mortality in New York,[1] 54.5% of the infants were associated with one or more social, demographic, medical, or obstetrical risks. Infant mortality ranged from 11.9 per 1000 among those with no risk factor to 41.6 per 1000 among those with both sociodemographic and medical/obstetrical risks. Of the 28.9% of infants with medical/obstetrical risks, most (24.3%) were identifiable at the first prenatal visit, 4.2% during pregnancy, and 5.5% at delivery. Using birth-weight as outcome and personal, familial, and community-related variables as risk factors, Lewis et al.[2] could explain 54% of the variance of low birth-weight ratios in American urban communities by six variables. Only 2% of that figure was attributable to single and interactive effects of medical care and income.

Alberman & Goldstein[3] were able to identify 26.3% of handicapped children in 13.2% of the population, using combinations of parity, method of delivery, and neonatal illness. In other words, nearly three-quarters of the handicaps in 86.8% of the population could not be predicted in this way.

As the sensitivity and specificity of available methods of risk identification are low (see Section 2.3) the impact of intervention based on risk strategy cannot be high from the viewpoint of the population. From the viewpoint of the individual, the intervention may be crucial.

The last limiting factor is the effect of late intervention on outcome. With limited resources, the possibility of reducing the undesired outcome may be small. On the other hand, preventive measures, e.g., reduction of grand multiparity by family planning, may have a marked effect.

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[1] Chase, H.C. A study of risks, medical care and infants mortality Am.J.Public Health, 63(9): suppl. (1973)

[2] Lewis, R. et al. (1973) Relationships between birth weight and selected social, environmental and medical care factors. Am.J.Public Health, 63:973-981 (1973).

[3] Alberman, E.D. & Goldstein, H. The 'at-risk' register: a statistical evaluation. Br.J.Prev.Soc.Med., 24: 129-135 (1970).

2. Measurement of effect of different resources

Resources (Section 3.2) are of different types and exist at different levels. Is it possible to measure them on a single scale? One proposal is to measure them in terms of their effect on the outcome. If a given number of antenatal visits (and the interventions consequent on them) reduce perinatal mortality by 10% below that expected without them, then these visits may be allotted a value of 0.1. Another resource, delivery by an obstetrician, might lower perinatal mortality by 8% and be given the corresponding score.

This would be a complex method but well worth trying; even on the basis of crude estimates, the advantages are the ability to measure all resources on a common scale and to make rational reallocation decisions as well as to give a baseline measure providing information on current allocations to individuals at different risk levels.

3. Sample size requirements

The following examples indicate the approximate size of the populations to be studied where the probability of detecting differences is 95% or more and where the differences are significant at the 5% level. The assumption is made that there are equal numbers in each of two groups. The two groups could be, for instance, those, otherwise equal, in which different resource allocations have been made with different levels of outcome.

3.1 Perinatal or infant mortality

Approximate sample sizes* needed:

		Mortality rate per 1000 in population no.1				
		60	70	80	90	100
Mortality rate per 1000 in population no.2	50	33 000	9 000	4 300	2 600	1 800
	60	-	39 000	10 000	4 900	2 900
	70	-	-	44 000	12 000	5 500
	80	-	-	-	50 000	13 000
	90	-	-	-	-	55 000

*Note: The chance of failing to detect the difference is 5% or less and the two population samples are of equal size. If S^2 is the variance of an individual, X the difference between populations, and N the number in both samples together,

then $N = \frac{64S^2}{X^2}$

3.2 Birth weight

Assuming a standard deviation of 600 g, then

for an average difference in birth-weight of	50	100	150	200	250g
the population sample size (N) is	9 200	2 300	1 000	600	4 000

APPENDIX 3

Four examples of expansion of general objectives using maternal anaemia as the risk factor and birth weight, perinatal mortality, and growth and development as outcome variables

(numbers in brackets refer to points 1-13 on the following page).

1. Detect pregnant women with anaemia

This could be expanded as follows:

- contact at least 95% of the pregnant population by the middle of the second trimester and complete the initial questionnaire (1);

- perform haemoglobin estimation once on at least 90% of these (2);

- define as anaemic all women with haemoglobin levels below the mean value minus one standard deviation for the population (3).

2. Treat > 95% of those with anaemia

- Provide a daily food supplement with x calories and y grams of protein until the day of delivery (4);

- give 200 mg ferrous sulfate, in tablet form, daily (5);

- see each woman weekly to check that the supplementary food and the iron are being taken (5);

- give advice or refer all women who show defined complications (6).

3. Record the outcome of all pregnancies in the community

- Record details of the delivery and any complications (7), referring deliveries with defined complications;

- record sex and whether infant born alive or dead (8);

- record infants born alive who died shortly afterwards (8);

- weigh the baby within 24 hours of birth and record the weight (9).

4. Follow up all live-born infants in the community

- Record any infants that die and the date of death up to the age of 18 months (10);

- weigh each baby and measure length at 90 and 180 days old and at 18 months (11);

- record the feeding patterns (12);

- record diseases since the last visit (10);

- refer all babies with deficient growth and development (13).

The following points (1-13) are a further elaboration of the examples enumerated on the previous page:

(1) Who will make the initial contact? How will the contact be made? What facilities exist to ensure completeness of registration? What items will be included in the questionnaire? How can this phase be monitored and evaluated?

(2) Who will do the haemoglobin estimation? Using what method? What degree of accuracy is required and how will this be checked? What is to be done with the noncompliers?

(3) How will this be done? What is the minimum number of women to be tested to make this calculation? Would it not be better to decide on an arbitrary cutoff point, say, 90 or 100 g/l?

(4) A suitable supplement would probably be 1250J per day if there is no protein deficiency. How would this be determined? What should the supplement comprise? Presumably locally available and acceptable foods but with added vitamins and folic acid? What measures should be taken to record the amounts ingested by the patient?

(5) How can one ensure that the iron is taken? Label with a dye which will be excreted in the urine? What steps ought to be taken in the case of noncompliers?

(6) What are the complications and how are these defined for the field worker? What advice should be given in each case and under what circumstances should patients be referred? To whom should they be referred and how will they get to the place of referral?

(7) Deliveries may be at home and the person recording the details may not be the midwife. What items are to be recorded? How are these defined for the person recording?

(8) These factors require definition. How long and how frequent should be the follow-up?

(9) Who will weigh the baby? If not the midwife, then the person recording the weight must be resident in the village. How, precisely, will the baby be weighed, according to what scale, and with what degree of accuracy?

(10) How frequently should babies be contacted, and what are the tasks at each contact? What should be noted? If diseases, which ones and how defined?

(11) How should length be measured? To what degree of accuracy?

(12) If breast plus supplements, how to record this? Should one not be giving service, i.e., advice on feeding and, if so, how will it affect the results?

(13) This, too, will need to be defined. Should the weight be recorded on a chart? What advice should be given if the curve falls off? At what point should advice be stopped and the baby referred?

APPENDIX 4

List of members of the Task Force on "Risk Approach" for improved maternal and child health and family planning

The strategy of the risk approach for maternal and child care was developed by a task force with the following participants, to whom the World Health Organization expresses its gratitude:

Dr E. Maurice Backett (Chairman)
Department of Community Health
The University of Nottingham
Medical School
Nottingham, England

Dr Neville Butler
Royal Hospital for Sick Children
Bristol, England

Dr A. Michael Davies (Rapporteur)
Department of Medical Ecology
The Hebrew University
Hadassah Medical School
Jerusalem, Israel

Dr Nusret H. Fisek
Director
Institute of Community Medicine
Hacettepe University
Ankara, Turkey

Mr Harvey Goldstein
Lecturer in Statistics
National Children's Bureau
London, England

Dr Raj Karim
Deputy Director of Health Services (MCH)
Ministry of Health
Kuala Lumpur, Malaysia

Dr Z.K. Stembera
Research Institute for the Care of
Mother and Child
Prague, Czechoslovakia

The following members of the WHO Secretariat participated in the task force:

Miss E. Barton, Division of Family Health, WHO, Geneva, Switzerland

Mr P. Kaufmann, Health Statistical Methodology, Division of Health Statistics, WHO, Geneva

Dr E. Liisberg, Division of Family Health, WHO, Geneva

Dr J. Osuna, WHO Regional Office for the Americas, Washington D.C.

Dr A. Petros-Barvazian (Secretary), Maternal and Child Health, Division of Family Health, WHO, Geneva

Dr S. Plaza de Echeverria, Maternal and Child Health, Division of Family Health, WHO, Geneva

Mr L. Roy, Division of Strengthening of Health Services, WHO, Geneva

Dr A. Rossi-Espagnet, Health Service Information Systems, Division of Strengthening of Health Services, WHO, Geneva

Mrs C. Willumsen, Maternal and Child Health, Division of Family Health, WHO, Geneva

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